Reports on the Marine Biology of the Sudanese Red Sea.—II. Narrative of the Expedition.

By Cyril Crossland, M.A. (Cantab.), B.Sc. (Lond.), F.Z.S.; late Lecturer in the University of St. Andrews. (Communicated by Prof. W. A. Herdman, F.R.S., P.L.S.)

(Plate 1.)

[Read 2nd May, 1907.]

In November 1904 I had an opportunity of visiting the Red Sea and of making collections of the marine fauna, which I hope may afford an interesting comparison with the numerous collections from the Indian and Pacific Oceans made in recent years.

Several famous collections have been made in the Red Sea already, notably those by Ehrenberg in 1870 ; but of the less commonly known groups which have no readily preserved hard parts, not many species are recorded from the northern and middle parts of the area.

Collecting Grounds and Habitats.—1. Suez.

At Suez I spent several weeks, of which a large proportion was given to collecting, principally from the very extensive mud-flats which lie alongside the causeway connecting Port Tewfik with the mainland.

The most dreary and uninviting uniformity of these flats gives place to considerable variety on closer acquaintance, the muds and sands being of varying consistency and constitution with corresponding variety in the fauna they support. The sand is composed in places largely of foraminifera, some areas are covered with sponges, some with weeds. Stones are rather rare, except on the east side at Port Tewfik, near the point where the Suez Creek joins the Ship Canal, where probably their presence is artificial.

Owing to the peculiar tidal conditions of the Red Sea, this is almost the only opportunity I had of digging for worms in sand and mud left uncovered by the sea. At Suez "springs rise 7 feet," but the tides are irregular, their times and height depending on barometer and wind. At the other end of the sea, in the Bab el Mandeb, a considerable tide occurs, but the middle of the sea, as at Suakim, is practically tideless.

Dock walls, the under sides of buoys, and the bottoms of ships in dry dock all yielded harvests.

Suez Bay is shallow and muddy (whence the magnificent green colour which forms such a contrast with the reddish mountains of Ataka), but trawling produced quantities of fine Alcyonarians, Echinoderms, and Sponges, the latter, as always, being the home of many Polychæta and Crustacea. I much regret that I had few opportunities of using the trawl here. I believe much remains to be reaped.

On the Etuleh and Kal el Kebira shoals abound corals of reef-forming species with the Alcyonarians so characteristic of the tropics. Their luxuriance is perhaps not quite that attained further south, but is amply sufficient to constitute a typical specimen of tropical life. This is at 29° 58′ N. latitude; whereas on the other side of Africa corals are scanty, and most forms of life are those characteristic of the Mediterranean, as far south as the Cape Verde Islands in lat. 15° N.*

Suez is indeed the place for a tropical laboratory; less than a week from London, most species of the tropics can be studied without any of the discomforts of heat. Indeed I can testify that Suez has the best climate to be found in Lower Egypt, Alexandria not excepted.

2. Red Sea, West Coast Harbours.

During my voyage south, which I made in a small vessel, I was able to see many little-known harbours and reefs of the Western Shores. The uniformity of the biological conditions of the Red Sea was the most striking impression received, and subsequent more detailed explorations have done little to modify this.

Of all seas this deserves best the name of The Coral Sea. Its shores are all composed of elevated coral, and are fringed with its luxuriant growth; while Barrier and other reefs and patches fill the sea for miles from either shore. In short, corals luxuriate everywhere (with one partial exception noted below) except in the most stagnant creeks.

For a detailed description of this coast I refer to the paper following. The presence of very numerous inlets into the coral plain is a specially important feature from the collector's point of view. These are, however, all of the same type—an opening in the fringing reef bounded by precipitous banks of coral, which extend as submarine walls along each side of the canal-like creek. The species of coral change as one goes up the creek and several kinds of Alcyonaria become prominent, great sheets of brown *Xenia* being especially characteristic of sheltered and cloudy water.

Only close to the head of the tideless landlocked canals do corals disappear and give place to bare mud or sand, with *Zostera* and *Halimeda* as the usual seaweeds of this habitat.

So if we reckoned all coral-reefs alike, we have conditions of extreme simplicity—land and sea both being coral and the products of its decay. But besides the infinite complexity of each coral-reef considered by itself, it must be remembered that the reef of the open sea is quite another thing to the product of perhaps equally luxuriant growth in sheltered water.

* Crossland, C. "The Œcology and Deposits of the Cape Verde Islands," P. Z. S. 1905, pp. 170–186.

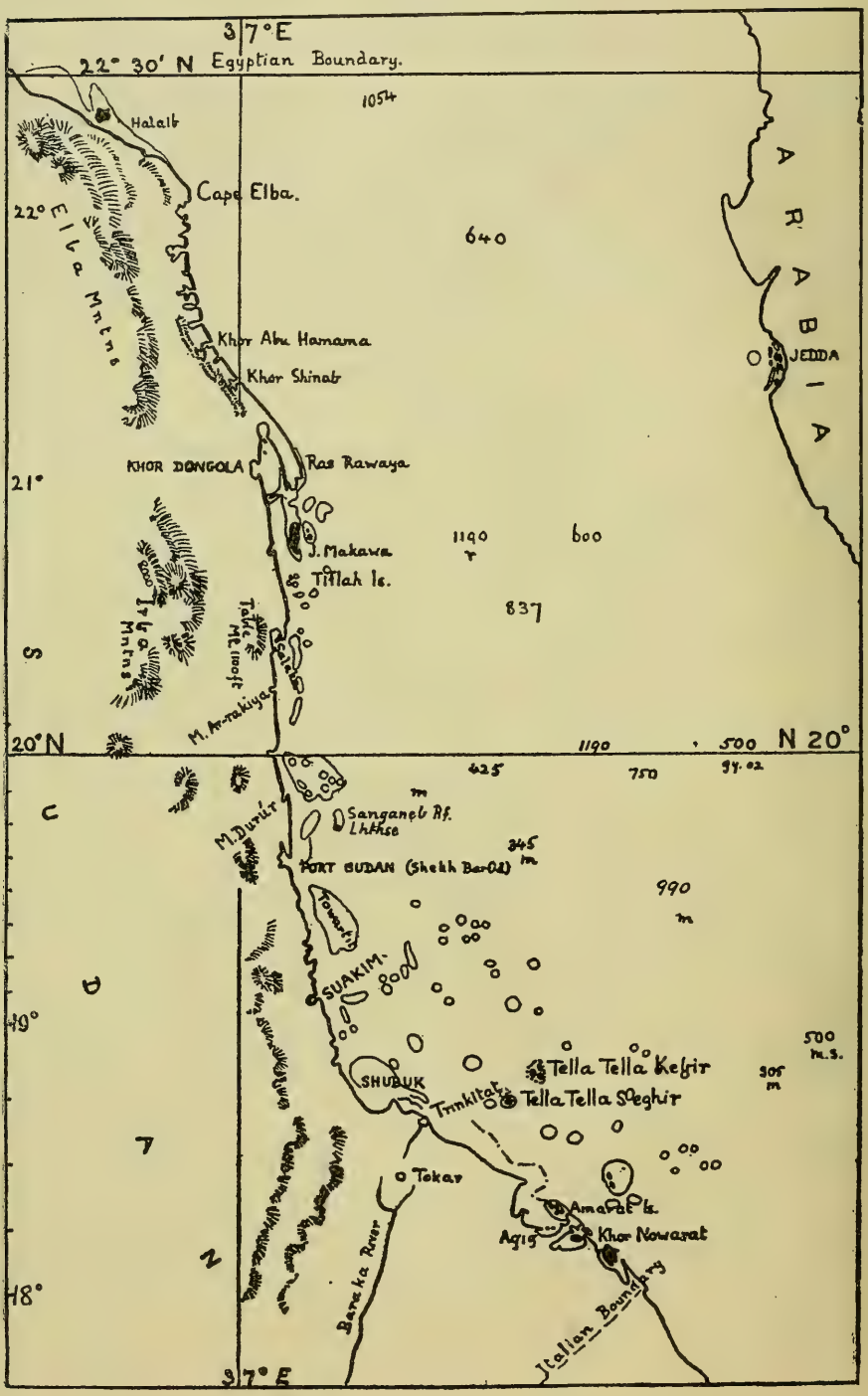
3. Sudan Coast.

Between latitudes 21° 30′ N. and 18° N. I made a particular examination of the coast and found but one exception to the above described uniformity. This is the large enclosed bay of Dongola (or Dongonab as it is more properly called), the peculiar structure of which is probably connected with its biological uniqueness. In the map on p. 15 the thin lines represent reefs and shoals, and it is seen that the area may be described as three deep basins, of which the first is open to the south. The boundary between this and the second is a reef covered by 1 fathom on the west and 2½ fathoms on the east side of the long narrow island which occupies its middle part. The partition between the second and third basins is formed by a large sand-island and the shoals lying round it. Now on the south side of the former barrier all shoals lying below the level at which coral grows with luxuriance are covered with sand and sparsely scattered coral colonies, of which many are dead, just as elsewhere in those places where there is any step between the coral cliff and the floor of coral-mud. North of the barrier on the other hand, the corresponding position is generally occupied by nullipores, either in the form of nodules composed of *Lithothamnion* alone or larger masses of a combination of coral and nullipores, of which the latter is predominant and practically hides the former. There are exceptions, some small nullipore patches being found just south of the barrier and coral occurring in places north of it; but the description holds good that south is a coral area, north is nullipore. But it must be remembered that this applies only to water of 2 or 3 fathoms and over. In the shallows down to 1 fathom corals flourish on both sides of the barrier alike.

In a few places north of the barrier we find surface reefs of rather a peculiar constitution, viz., a combination of coral and nullipore in which the former is necessary as a nucleus for the latter but is almost hidden under it. The coral is not merely dead and overgrown, but still lives on at the ends of some of its branches, a balance being obtained like that between the conflicting interests of parasite and host. The combination has a wonderful rich appearance, being covered again with green and brown moss-like sea-weeds growing with such vigour that striking a "stone" with a hammer causes an effervescence of oxygen bubbles.

If the reason for this change were known in the case of this restricted area, it might throw some light on the unexplained absence of coral, on the reef-forming scale, from the east coast of Zanzibar and British East Africa and other places, where there is no apparent reason for its inability to flourish. Unfortunately there is no solution as yet; I can only state the problem.

FIG. 1.



MAP OF THE SUDAN COAST.

The possible causes of the restriction of coral-growth in general are :—

(1) Cold currents.
(2) Very strong currents.
(3) Dirtiness of the water.
(4) Chemical composition of the water including its dilution by fresh water.

(1) and (4) are dismissed at once as inapplicable to either this case or to that of British East Africa. It has been shown too that the effect of an ordinary river upon reefs a comparative short distance from its mouth is generally inappreciable. But there are no permanent rivers in this part of the world.

(2) Strong currents are present in this neighbourhood, but as a matter of fact currents stronger than occur here are generally favourable to coral-growth.

(3) The water in the north basin, where coral grows luxuriantly, forming reefs rising precipitously from deep water, is very dirty, as cloudy as that of Suakim Harbour, for example. That of the middle and southern basins is clear ; even when the strong north wind of winter is blowing, the bottom is clearly visible to a depth of 5 fathoms, and in the summer, when winds of a more normal strength prevail, objects are distinguished clearly at 10–13 fathoms.

Methods of Collecting.

Collecting by dredge and trawl is difficult in a sea where coral is so ubiquitous. Even on the nullipore beds of Dongola "stones" large enough to stop the working of small apparatus abound nearly everywhere. Consequently the majority of my specimens from depths of more than a few feet were obtained by divers or by trawling on coral-mud. Compared with the harvests reaped from other grounds, the results from the latter seem poor. Large quantities of the slender branches of an Antipatharian, certain Polyzoa, several species of Lamellibranchs, &c., were often obtained, but their repeated appearance became monotonous.

Coral colonies brought up by divers, and either broken up at once or left standing in fresh water until the inhabitants came out of their burrows and tubes, yielded many and varied specimens. On one occasion I employed three men for several days in taking coral from a shoal and breaking it up on shore. One result of this was to alter my ideas of the relative abundance of certain forms of life.

One hears little of the use of divers in accounts of collecting expeditions. In most places it is easy to find skilful "swimming divers," and by learning a few words of their language one can easily get them to bring up the particular coral, sponge, alcyonarian, or weed which one has picked out by the water-telescope. In a tideless sea like this their help is invaluable, and indeed in most seas the desirable specimens seem to be just outside the reach of the collector confined to between tide-marks and dredging.

Trawling in the Bay of Agig Suraya was exceptional, resulting in the

finding of a patch of the branching tubes of a species of Lepralid polyzoan. Few Crustacea were found among these, but the number of Polychæta was enormous. The most important is a species of *Chætopterus* whose tubes were enfolded by the polyzoan, and occurred in large numbers. The species is probably that which I named *C. longipes* *, from a single specimen obtained by J. Stanley Gardiner in the Maldives. But the great majority were small forms, and by placing a tub full of the polyzoan in fresh water overnight, I obtained about 4 oz. of representatives of the following families:—

Terebellidæ : 2 species, one of which made up the bulk collected.
Polynoids: in large numbers.
Nereids: 2 species. Numerous.
Eunicidæ: a few dozen.
Syllidæ: 2 or 3 species. Fair numbers.
Sabellidæ: 1 species. Fair numbers.
Serpulidæ and Chætopteridæ. Abundant.

A few each of:—

Lumbriconereids.
Hesionids.
Phyllodocids.

Besides taking every opportunity of examining buoys and their ropes and so on, it is worth while, if one is staying a month in one place, to sink half-a-dozen paraffin boxes, or suspend them in the water, and examine at the end of one's stay. In the present case the boxes remained down for a period of five weeks, and at the end of that time presented a wonderful appearance, being completely covered with brilliantly coloured compound and simple ascidians, some sponges and hydroids and swarms of young lamellibranchs. Among these live hosts of free forms. In this way one obtains an abundance of specimens of species otherwise rare, or not met with at all; in the present case this applied especially to the Planarian worms.

Comparison of Fauna with that of the Equatorial Coast of Africa.

On the whole the two faunas seem much alike, the differences observed being perhaps attributable to the differences of habitat and to the œcological effects following on the unknown factor which encourages the growth of corals here while suppressing them on the Equator.

Alcyonarians †.—In both localities certain forms, especially the Xeniidæ, are in places as abundant as are fucoid weeds on English coasts; but while the lowest tides of Zanzibar uncover sheets of blue and blue-greens, the shallows of the Red Sea harbours are carpeted with brown. The rapid and continual motion of some of these brown and grey Xeniidæ, which

* P. Z. S. 1904, i. p. 277.

† *Cf.* the account of the East African forms by Prof. J. A. Thomson, P. Z. S. 1906, i. pp. 393-443.

fold the tentacles simultaneously over the mouth and straighten them again, is one of the strange things to be seen by the use of a water-telescope. The phenomenon is, I believe, unique among fixed Cœlenterates.

Tubipora is comparatively rare on this coast, though I believe that in other parts of the Red Sea it is as abundant as in the shoals of Zanzibar Channel.

The Planarians * are a group which is only beginning to be known and of which large collections must be slowly accumulated before true comparisons of faunas can be made, but I believe a considerable resemblance between the two regions will be shown by Mr. Laidlaw's papers.

To the Opisthobranchs † the same remark applies, and in addition the migratory habits of many species make it impossible to obtain a fair collection in less than a year's time. The difference in the conditions under which collection was carried on will account for differences in the lists of species quite independently of the real facts of distribution. For instance, the very large and conspicuous *Hexabranchus* was quite common about Zanzibar, whereas here I have seen but one specimen. On the other hand, I believe I collected only one specimen, and that a small one, of *Chromodoris elizabethina* on the equatorial coasts; here I have collected many and have seen, I confess, more than I have captured. I have never yet seen here the great swarms of Aplysiidæ which I met with on the shores of Zanzibar and the Cape Verde Islands.

The Echinodermata are in both localities characterized by the abundance and beauty of the Comatulidæ and the large size of the Holothurians. The latter are not fished as "Trepang" in the Red Sea, the several valuable species known as "Teat fish" being rare or absent.

The brilliant *Pentaceros Lincki* is common here as in East Africa and Ceylon; as are the species of *Linckia*, of which all stages of its peculiar vegetative mode of reproduction are to be met with frequently.

The single littoral Oligochæte is a new species, and has been described under the name *Pontodrilus crosslandi* by Mr. Beddard ‡.

Polychæta.—The ease with which a fair number of species of this group may be collected, together with the diversity of their habits and habitats and the fact that most of them are practically fixed organisms, make the group a specially useful help in studying problems of distribution. Of the few Equatorial species I have so far had opportunity of identifying §, all the

* F. F. Laidlaw, P. Z. S. 1903, pp. 99–113, & 1906, ii. pp. 705–719 (two papers on the East African Collections).

† Sir E. C. Eliot, P. Z. S. 1902, ii. pp. 62–72; 1903, i. pp. 250–257, ii. pp. 354–385; 1904, i. pp. 386–406, ii. pp. 83–103, 268–298, and onwards; also 'Journal of Conchology,' xi. (1905) pp. 237–256, (1906) pp. 298–315, 366–367.

‡ P. Z. S. 1905, ii. [1906] pp. 558–561.

§ C. Crossland, "Fauna of Zanzibar," &c., P. Z. S. 1903, i. p. 169, and onwards to 1904, i. pp. 287–330.

commoner have turned up again in the Red Sea, as have many of those conspicuous forms which are at once recognizable by their colour or tubes.

Plant life resembles that of Equatorial East Africa, in that most of the species are the same, but occur in different proportionate quantities. The absence of coral on the East African reefs is correlated with the vast quantities of the marine phanerogam *Cymodocea ciliata*, Ehrenb., which there occupy the spaces here covered with coral, but even on mud or sand-areas this species is not often met with on the Red Sea coasts. The true seaweeds are the same, but again there is far less ground suited to *Halimeda* spp., which are consequently less frequently met with and then in less abundance.

On shore Mangroves are absent, perhaps because there is no tidal action to plant their floating embryos. Its companion *Jussieua*, with its aerial peg-like roots, is frequently found, but not often in large numbers.

The salt pools found here and there on these arid coasts soon evaporate to a slush of salt crystals, and in these a red microscopic alga flourishes to such an extent as to colour the whole pool. Whether the name "Red Sea" is given from this alga or from the pelagic form which makes a scum as if of iron rust over large areas of the sea occasionally during calms, or from the brown Xeniidæ which carpet the harbour sides, is indeterminable; any one of the three is a striking phenomenon, the first being obvious to shore dwellers, the second to sailors. Perhaps after all, the name was given by landsmen who noted the prevalence of red colour in the hills which border the sea throughout its length.

Reports on the Marine Biology of the Sudanese Red Sea.—III. Note on the Formation of the Shore-cliff near Alexandria.

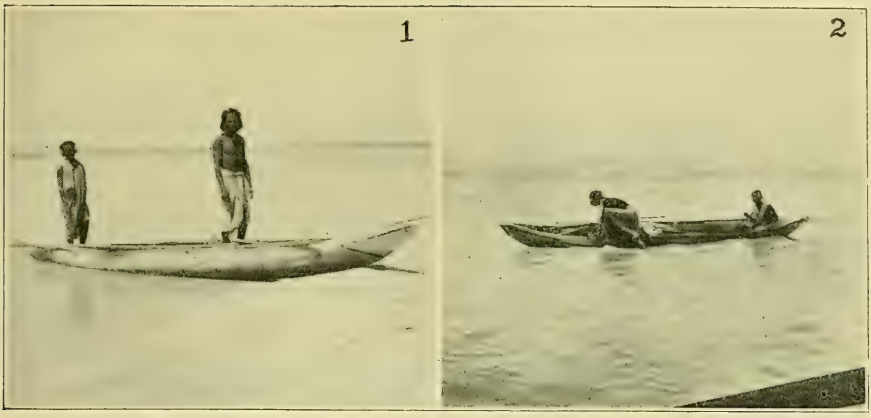
By Cyril Crossland, M.A., B.Sc., F.Z.S. (Communicated by Prof. W. A. Herdman, F.R.S., P.L.S.)

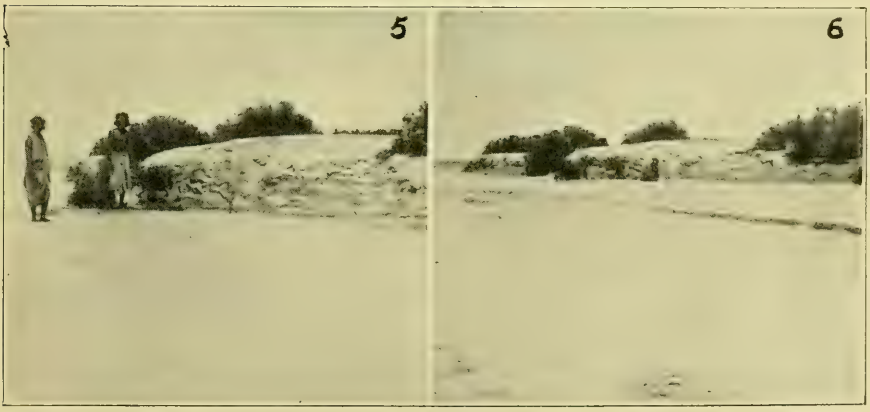
(Plates 2 & 3.)

[Read 2nd May, 1907.]

The *Coast of the Delta* is in the form of an arc of a circle except on its west side, where it runs almost in a straight N.E. and S.W. line from Alexandria to Abukir. These two sections of the coast differ markedly, the former having a very low and sandy shore generally backed by swamps or lakes, the delta being in process of extension, the latter being bounded by low cliffs due to the rapid erosion of the land by the sea. (See Plate 2. figs. 1 & 3.)

The cliffs, with an exception to be noted later, are of the softest material throughout, yet always nearly vertical; a fact the significance of which one would have supposed could not have escaped the notice of the builders of the





C. C. Photo. Grout, Engr.

SCENES IN THE RED SEA.